Panelist Name:

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Question:

"During the period of the fishery, has the carrying capacity of the ETP for dolphins declined substantially or has the ecological structure of the ETP changed substantially in any way that could impede depleted dolphin stocks from growing at rates expected in a static ecosystem? Or has the carrying capacity increased substantially or has the ecological structure changed in any way that could promote depleted dolphin stocks to grow at rates faster than expected in a static ecosystem".

Opinion Synthesis:

The limited physical oceanographic data available for the ETP indicates that there has been, at least, sea surface temperature has been increasing since the early 1980s. Evidence from pelagic and coastal ecosystems in virtually all other of the world's oceans that there have been biological effects of similar regional ocean climate change during the past several years is compelling. Consequently, the argument is persuasive that the carrying capacity of the ETP, relative to the ecologies and life histories of northern offshore spotted dolphins and eastern spinner dolphins, is lower now (and the past several or more years) that it was prior to and during the early phase of the fishery. Moreover, there is some evidence (from dolphin stock point abundance estimates) that the dolphin stocks may have begun recovering once direct mortality in the fishery was reduced to levels below replacement rate but that at least two periods of recovery (late 1980s and late 1990s) may have been interrupted by several, closely occurring, substantial El Nino warm water events. The most recent dolphin stock point estimates indicate initial recoveries similar to those in the late 1980s and which would be expected for large, long-lived mammals following an event that had particular life history effects (e.g., reduced physical growth and survival on young animals, delayed sexual maturity in survivors, etc.) Available data on relative prey abundance suggests that those populations were reduced in association with the warm water events and then recovered during subsequent cold water events, and that the dolphin stocks responded to those changes.

There are insufficient data to determine whether the ecological structure of the ETP ecosystem has changed either during the past several decades or during specific

warm water-cold water oscillatory events, though limited data on bird and other marine mammal fauna suggest that it may not have changed substantially.

Discussion:

A. To approach this multi-part question I partitioned it into its component threshold and secondary qualifying questions:

1. Has the carrying capacity of the ETP changed?

    a. If evidence indicates that the carrying capacity of the ETP has changed, could this change have been sufficient to affect population growth of depleted dolphin stocks.

        1. Could this affect have been great enough to result in demographic change sufficient to prevent the depleted stocks from increasing at rates that might be expected for similarly-situated populations in a system where carrying remained at pre-fishery (i.e., purse seining for tuna on dolphin schools) levels, or

        2. Could this affect have been great enough to result in demographic change sufficient to enhance population growth of the depleted stocks to result in rates of increase greater than might be expected for similarly-situated populations in a system where carrying remained at pre-fishery (i.e., purse seining for tuna on dolphin schools) levels.

2. Has the ecological structure of the ETP changed substantially?

    a. If evidence indicates that the ecological structure of the ETP has changed, could this change have been sufficient to affect population growth of depleted dolphin stocks.

        1. Could this affect have been great enough to result in demographic change sufficient to prevent the depleted stocks from increasing at rates that might be expected for similarly-situated populations in a system where carrying remained at pre-fishery (i.e., purse seining for tuna on dolphin schools) levels, or

        2. Could this affect have been great enough to result in demographic change sufficient to enhance population growth of the depleted stocks to result in rates of increase greater than might be expected for similarly-situated populations in a system where carrying remained at pre-fishery (i.e., purse seining for tuna on dolphin schools) levels.

B. The "carrying capacity" question

The **root of this question** is whether there have been changes in the quantity or quality of physical or biological nutrients/resources in the ecosystem where the depleted dolphin stocks live.

I considered there to be **two issues** in this nutrient/resource question, which differ in temporal scale. The **first issue** is whether there have been either consistent trends in increasing or decreasing nutrients or saltational changes in nutrients/resources that have resulted in the lower levels of those resources in recent years compared with levels that existed before the purse-seine fishery for tuna (by setting on dolphins) began. The **second issue** is whether there have been substantial fluctuations in nutrients/resources during the fishing period, and particularly since the levels of direct mortality of dolphins in the fishery declined to demographically insignificant levels.

Facts regarding the **first issue**:

The reports and summaries provided to the Review Panel presented two key findings that were supported by substantive evidence.

1. There was a 'regime shift'/'climate change' in the middle to late 1970s in the North Pacific Ocean resulting in substantial and significant warming of surface waters in that region.
2. That shift/change was recognizable in the ETP as a significant increase (+0.27°C) in sea-surface temperature.

Other data were either lacking or inadequate to determine whether there were any significant changes in the nutrients/resources in the ETP as a consequence of the regime shift/climate change. Though the reports and presentations speculated that small changes in sea surface temperatures may not likely result in substantive biological changes, no data were available from the ETP to support that argument. Panelists commented that substantial and significant biological changes have correlated with small changes in physical parameters in areas where demonstrative data have been collected.

Based on this synthesis the answer to the first threshold question is that there are either no data or that some limited data are insufficient to determine whether the observed changes in one measured index of physical oceanographic change resulted in changes in

the nutrients/resources in the ETP. Consequently the qualifying questions cannot be reached[1].

Facts regarding the **second issue**:

The reports and summaries provided to the Review Panel presented two key findings that were supported by substantive evidence.

1. There was substantial inter-annual variation in sea-surface temperatures, wind patterns, and thermocline depth in the ETP during the period that the fishery has operated and this variation corresponds with warm water (El Niño) and cold water (La Niña) events in the ETP specifically and North Pacific Ocean generally.

2. Data on the relative abundance on several prey fishes and squids suggest that populations of those species may have been substantially affected by those warm and cold water events. Their relative abundances increased substantially just following the warm-water events of the 1980s. No data existed for the warm water events of the early 1990s but their relative abundances were substantially lower just following the intense 1997 warm water event than they were in 1990, after several years of increase.

These findings may indicate that biological resources change substantially as a result of large short term changes in physical characteristics of the ETP (i.e., that carrying capacity varies substantially over short time scales). If this is true then this component question of the threshold question is yes, and consequently the qualifying questions can reached.

Because changes in biological resources associated with these El Niño-La Niña events are cyclic they may enhance population recovery at times and impede it at others, through direct effects on survival of some individuals and age classes and indirect effects on physical growth, age at sexual maturity, and pregnancy rates of others. Spotted and spinner dolphins have obviously faced these cyclic events through evolutionary time and their life history patterns likely reflect adaptation to these selective pressures. Consequently, resolution of the question then about whether these short term fluctuations in carrying capacity may be substantial enough to either enhance or impede population recovery depends on an understanding of the response time to favorable or unfavorable conditions relative to the timing of the next cyclic event, notwithstanding and understanding of variable responses to events of varying intensity. If either the frequency or

[1] Professor Barber however presented model results to the Panel that indicated that nitrates, silicates, and primary production may have been substantially different from 1978 through 1991 than before. If this were true in the ETP then substantial biological changes would be expected based on persuasive or compelling evidence from other pelagic and coastal marine ecosystems elsewhere.

intensity, or both, of these events has increased in recent years, then patterns of recovery may differ from those predicted from evolutionary reasoning. There are evidently no demographic or life history data available from the depleted dolphin populations to explore these hypotheses.

However, there appear to be signs of population responses of the depleted dolphin stocks to El Niño-La Niña events in the abundance estimate trend data. The values of the point estimates of abundance for both stocks increased in the late 1980s through 1990, correlating with increases in the indices of relative abundance of prey fishes and squids following warm-water events. No data are available from 1991 through 1997, when two warm water events occurred, but the point estimates are low just following that period. Moreover, the pattern of the trend in point estimates of abundance and the correlation with prey abundance is the same for 1998 through 2000 as for the earlier survey period in the late 1980s. These patterns suggest that (1) the depleted stocks did indeed start to recover[2] after direct mortality declined below the replacement rate in the 1980s, but (2) that this recovery may have been interrupted by warm water events in the 1990s, and then resumed in the late 1990s. The persuasiveness of this argument is clearly affected by the large variability around the point estimates of abundance and the lack of evidentiary life history and nutrient/resource data.

C. The "ecological structure" question.

The data presented to the Panel in the reports and briefings do not support a comprehensive analysis of this question owing to inadequate comparative data on the composition and abundance of prey and predator communities. Some data on pelagic seabirds suggested that there were no differences between the two recent survey periods but were not adequate to determine if there were either longer term changes or shorter-term fluctuations. The data on other odontocete cetaceans are similar to those for pelagic seabirds.

Survey data indicate that populations of common and striped dolphins did not change between 1986 and 2000. These odontocete cetaceans are the most significant marine mammal competitors for prey resources for the depleted spotted and spinner dolphin stocks. Consequently, if the carrying capacity for the depleted dolphin stocks had either remained unchanged or increased during the operation of the fishery, populations of common and striped dolphins arguably should have increased. If the carrying capacity for these species had declined overall, then the pattern of stable populations of common and spinner dolphins could be a logical prediction.

[2] The annual rate of increase in the point estimates in the late 1980s was about 30%/year, which is clearly biologically unreasonable if due to intrinsic population growth and not the result of movement of animals into the survey area after egressing it earlier.